



# Preliminary Results from Monitoring an Elementary School Hot Water System

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# Presentation Objectives

- Describe site and testing goals
- Describe test plan
- Results:
  - Water Consumption
  - Energy Consumption
- Describe project next steps

# SITE DESCRIPTION:

## *Franklin Elementary School*

- **SoCalGas Site:**
  - Cafeteria serves students and families enrolled in Preschool-6th grade classes
  - Centralized kitchen, serves two remote schools
  - Open breakfast, lunch and dinner (5 days/week)
  - 1111 E. Mason St. Santa Barbara



# Baseline System at Franklin Elementary School



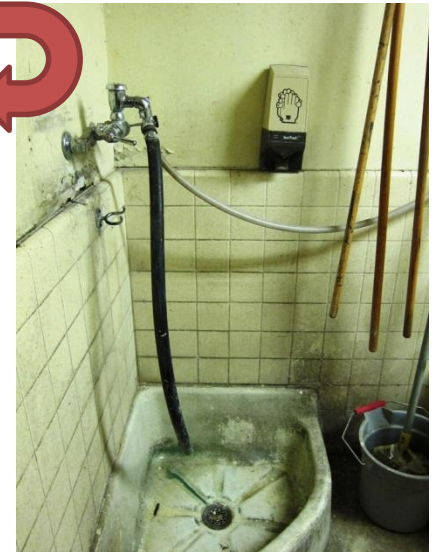
"180°F" Supply

Return Line



"140°F" Supply

Return Line





# Pre Rinse Operation Study

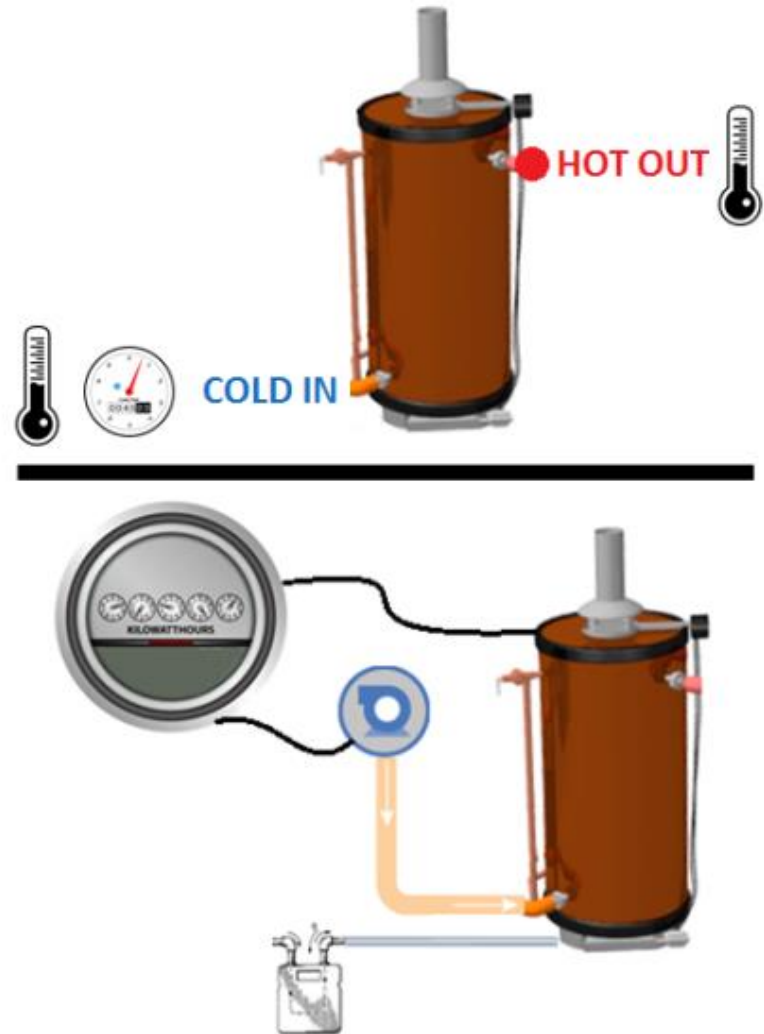


# Rack Conveyor Dishwasher Study



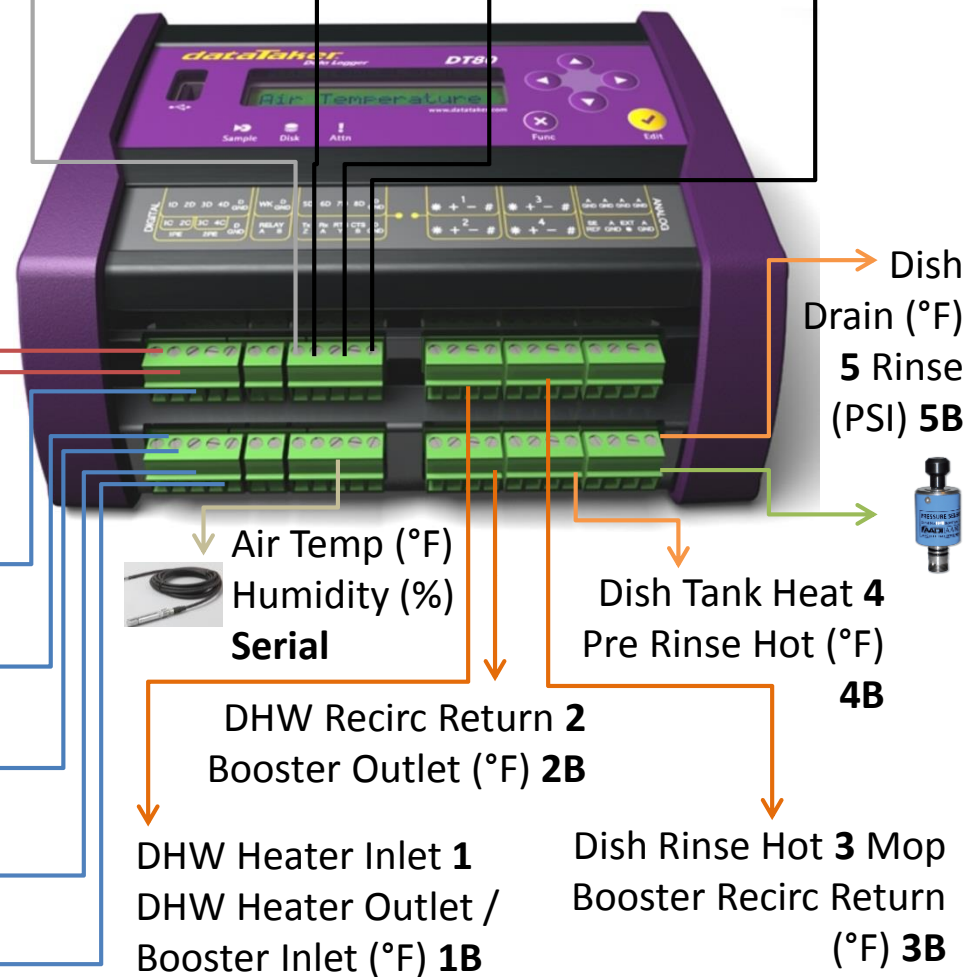
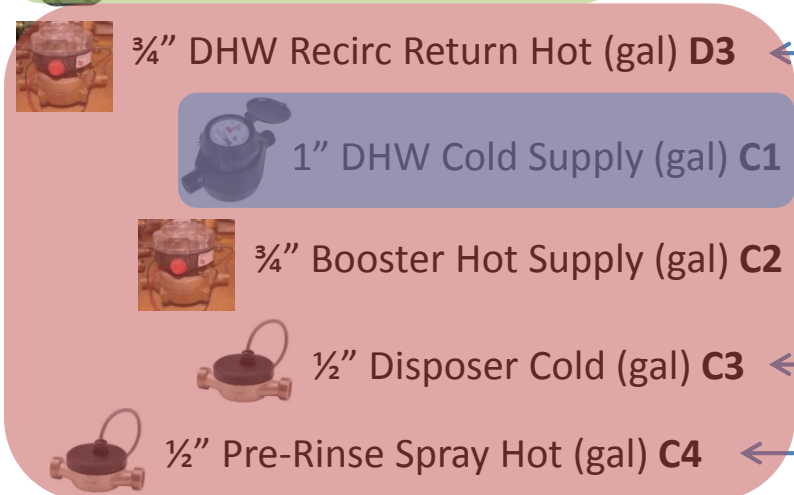
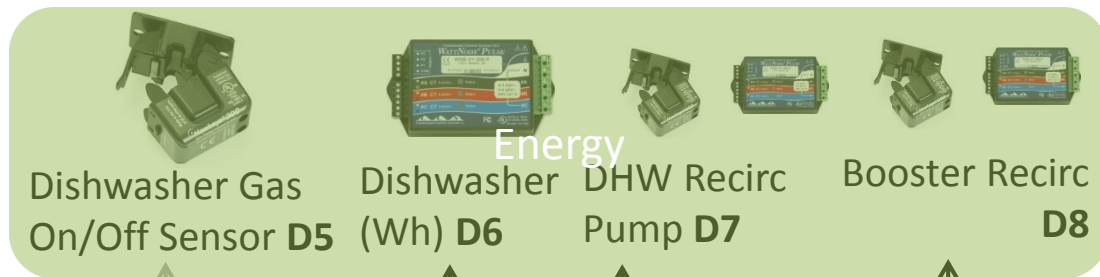
# System Efficiency Testing Goals

- Determine heat loss and actual operating efficiency of HWS
- Directly measure water, gas and electricity use
  - Total HWS
  - Major Components
- Cold water use at disposer
- Understand staff thermal comfort
- Use results to optimize retrofit
  - Overall replacement plan
  - Recirc pump timing





# Mechanical Room and Dishroom Sensor Mapping



# Average Temperatures During Flow

DHW in (F)	DHW out (F)	DHW return (F)	Booster Out (F)	Booster return (F)	Final Rinse (F)	Tank (F)
67	118	109	162	152	157	163

- Volume weighted temperatures
- Final Rinse temp never reaches 180
- TankF T > final rinse T

# Water Consumption (gal)

	Total Hot Water	Booster	Disposer (cold)	PRSV
Per Day	629.5	295.8	64.9	164.4
Per Hour Rinse	273.7	164.3	28.2	71.5

- Dishmachine rinse flow rate = 2.3 gpm
  - Rated rinse flow rate = 1.36 gpm
  - Rinse Water Use = 248 gal/d
  - Fill + top off = 47 gal/d
- Rinse time = 1.8 h/d
- Majority ~75% hot water consumption happens at dishwasher and PRSV

# Staff Training





# Energy

Booster Gas (therm/d)	DHW Gas (therm/d)	Dish Gas (therm/d)	Total Gas (therm/d)	Dishwasher Electricity (kWh/d)
2.41	5.17	5.12	12.70	3.8

- Overall, not a huge amount of energy use, but this site has major operating issues.

# DHW Recirculation

- DHW Recirc pump is on all the time at ~2gpm
  - 3180 gal/d consumption
- 9F temperature loss
- Daily heat losses = **2.7 therms/d**



# Booster Recirculation

- Booster is controlled by an aquastat
  - On at 1.5 gpm for 2.7 h/d
  - 243 gal/d recirculation
- 10F temperature loss
- Daily heat losses = 0.2 therms



# Water Heater Efficiency

- Rated efficiency of each water heater is 80%
- DHW input rate = 275,000 Btu/h
- Booster input rate = 199,000 Btu/h
- WHOE = Water Heater Operating Efficiency  
= Efficiency after recirculation losses

	Rated Eff.	Measured Eff.	WHOE
DHW	80%	74%	41%
Booster	80%	49%	47%



# Delivery Efficiency

- Out of Wall Delivery Efficiency to Dishwasher = 39%
  - POU Delivery Efficiency = 23%
- DE to Pre Rinse Sprayer = 47%
- Assume that all other points of use have an efficiency of 35%
- Overall delivery efficiency = 33%

# Optimized System at Franklin Elementary

## Replace (2) Standard Efficiency 80% TE Heaters with (1) Condensing Storage Modulating Heater

- Input gas rate of 199,000 or 250,000 Btu/h
- Rated at 97% TE
- Burner adjusts firing rate to the specific demand further increasing real-world efficiency
- Add improved water softeners/filters



## Replace Old Gas Fired 44"-Dishwasher with New Unit

- Add drain water heat recovery
- Add external gas booster heater in dishroom
- Add improved water softeners/filters



# Optimized Distribution System at Franklin Elementary

## Eliminate High Temperature Recirculation Line

- Reduces pipe heat losses significantly

## Install Variable Speed Pump with Timer

- Potential to reduce outlet temperature by controlling return temperature
- Timer can eliminate pipe heat losses during non-operating/non-cleanup hours

## Reduce Diameter of Vertical Pipe Drops to Compartment Sinks

- Improved hot water delivery performance
- Reduce pipe heat loss

## Insulate all Exposed Piping

- Reduce pipe heat loss
- Improve hot water delivery performance



# Thank You!

Questions?

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